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MASTERS OF MILITARY STUDIES

V-22 Osprey Program

Are we protecting this valuable asset and its passengers?

Does it meet the full requirement for USMC future medium lift assault operations?

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Executive Summary

Title: V-22 Osprey Program: Are we properly protecting this valuable asset and its passengers?

Does it meet the full requirement for all future USMC medium lift operations?

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Thesis: The V-22 is a technological leap in rotary wing performance characteristics and far exceeds the capabilities of the CH-46E but due to issues with protection, capabilities and cost it cannot safely fill the gap the United States Marine Corps has in assault support.

Discussion: Soon after the XV-15 was in a flight demonstration at the Paris Air Show in 1981 the Department of Defense started the Joint Service Advanced Vertical Lift Aircraft (JVX) program to investigate the use of tilt-rotor technology to replace the then current medium lift tactical transport aircraft in the military. From that point the V-22 program has gone through many controversial debates and decisions. One thing that has not been given enough thought is the great emergence of threats, vast proliferation of these threats and changing politics and the greater involvement of non-state actors. The tactics and operating parameters of Marines in the field have changed in the decades since the V-22 was conceived. All of these subjects together change the current and future threats the V-22 will encounter and should be addressed now.

Conclusion: The United States Marine Corps should take a serious look at two areas of interest. First, is that the protection of the V-22 is in jeopardy if changes in self-protection and escort capabilities are not made. Second, is the addition of another medium/heavy lift rotary wing assault support aircraft to fill the capabilities gap between the CH-53K and the V-22 in both cost and aircraft efficiency.

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Acronyms

AAA	Anti Aircraft Artillery
AGL	Above Ground Level
ASE	Aircraft Survivability Equipment
BP	Battle Position
CAS	Close Air Support
DA	Density Altitude
DIRCM	Directed Infrared Counter Measures
DR	Disaster relief
ECO	Enhanced Company Operations
FAC(A)	Forward Air Controller (Airborne)
FARP	Forward Arming and Refueling Point
FLIR	Forward Looking Infrared
GWOT	Global War On Terror
HA	Humanitarian Assistance
HOTAS	Hands On Throttle And Stick
HUD	Heads Up Display
IRCM	Infrared Counter Measures
LHA/LHD	Helicopter Landing Ship Class A and D
MANPAD	Man Portable missile
MEU	Marine Expeditionary Unit
MPS	Maritime Preposition Squadron
NATOPS	Naval Air Training Operating Procedures Standardization
R/W	Rotary Wing
STOM	Ship to Objective Movement

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Introduction

The United States Marine Corps has spent millions of dollars in recent years on high tech. weapons and systems to keep Marines out of harm's way. These weapons systems can do many things to reduce the risk of loss of life of American servicemen. This investment in technology is because the human cost of going to war has become too high for the American public to tolerate. Though the requirement for this reduction in loss of life is a lofty goal, the reality is that the United States of America often has to put military personnel on the ground to accomplish its mission and a loss of life may be inevitable. This disputed ground is usually hostile and far from the United States. To put personnel on the ground rapidly and with the greatest amount of flexibility in an austere environment, the United States needs helicopters and tilt-rotor aircraft. These aviation programs have been placed on the back burner in recent years with Congress instead putting money into programs that on the surface seem to reduce the risk of loss of life like unmanned aerial systems, tactical jets and sensors. However, without new helicopters and tilt-rotor designs, the U.S. may actually increase the risk of the loss of life due to the aging systems that are still being used with an ever-increasing frequency.

The first military version of the tilt-rotor is the V-22 Osprey. The V-22 has been embroiled in controversy for two decades but has emerged from both political and mechanical disaster. It can fly twice as fast, twice as far, and carry twice as many passengers as the CH-46E that it was designed to replace. However, protecting the V-22 and the warriors that it carries should still be a major concern. Additionally, using another aircraft to fill the capability and budgetary gap between the MV-22 and the CH-53E/K programs should be seriously looked at in the expected future of tight military procurement budgets. The V-22 is a technological leap in capabilities and far exceeds the capabilities of the CH-46E but due to issues with protection and cost it cannot safely or totally fill the gap the United States Marine Corps has in assault support.

Medium and heavy lift rotorcraft have become over taxed in recent years with Ship To Objective Movement (STOM), Enhance Company Operations (ECO), Humanitarian Assistance (HA)/ Disaster Relief (DR), dealing with the Global War on Terror (GWOT), and now piracy. The requirements for more speed, endurance and flexibility will only increase in the foreseeable future.

This paper will look at some of the shortcomings of the V-22 program and propose multiple solutions to better protect the V-22 and enhance the medium and heavy lift assault support requirement in the United States Marine Corps. This paper will not discuss exact system operating parameters or tactics to avoid classification of the paper. It also will not discuss in depth the psychological aspect of Marines being able to see and hear their escort and subsequent CAS (Close Air Support) platform since that would be another paper in itself. It will start with some of the history and controversy of the V-22 program then work through the present and into the future.

Issues

The issue of protection for this aircraft, that has operating parameters that are faster and with greater range than current rotary wing escort helicopters in the Marine Corps inventory and yet slower than tactical jets, has always been on the minds of engineers and Marines. The first gun study was conducted from May 1998 to August 1999. System requirements and integration tasks were determined at that time. The gun vendor competition was conducted and the General Dynamics Aircraft Systems (GDAS) GAU-19 was chosen from nine different weapons ranging from 7.62 mm to 30 mm in August of 2000. The weapon was to be a chin turret, helmet tracker with connections to the existing FLIR (Forward Looking Infrared) system. The GAU-19 had a field of fire +/- 110 degrees with elevation of 50 deg. down and 20 deg. up.[1] The weapons

system was subsequently eliminated for reasons of weight and budget at a time when it was more important to fix safety issues rather than to add a weapon to the V-22.

Another issue is the altitude limitation with passengers on board. With mountains in many of the possible future operating areas, the altitude limitation with passengers embarked greatly reduces the altitude buffer the V-22 touts as decreasing the probability of a shoot down. With the mountains in Afghanistan rising to over 21,000 feet, Pakistan going to over 24,000 feet, North Korea's mountains rising to over 7,000 feet, and Somalia having mountains up to 7,000 feet the V-22 is no longer flying well above the MANPAD threat.[2] Also, the lack of an active Infrared Counter Measures (IRCM) system similar to but more advanced than the one currently on the CH-46E the V-22 is replacing is a major issue. These will be discussed further together under threats. In the 2007 Time magazine article titled "Flying Shame" a 2003 Pentagon study was mentioned stating that 90% of the helicopters lost in Vietnam were lost on final approach when they were hit by ground fire. In the same article Retired Marine General and former Commandant of the Marine Corps James Jones was quoted as saying, "it's obviously technically feasible. We've got nose-mounted guns on Cobras and other flying platforms, and I thought all along this should have it too" when discussing the need for a defensive weapon for the V-22.[3]

The other issue that has plagued the V-22 for over a decade has been the cost. Over the years it has ballooned to well over double the initial estimate. To be fair, this has happened to many major aircraft designs and many other military acquisition programs and for a program as ground breaking as the V-22 it should be expected. Even with all the cost cutting measures that have been put in place from the acquisition team the cost of the V-22 has fluctuated greatly over the years. Initially the V-22s projected cost was about 24 million dollars each in the 1980s with a contract buy of close to 900 aircraft. The price then went up to over 70 million dollars each and was hoped to be reduced to 58 million dollars each by 2010 with a contract buy of about 460

aircraft between the Marine Corps, Air Force and Navy. Time, inflation and a large reduction in the number of aircraft to be purchased have come together to raise the cost per aircraft. It is now estimated that the cost per aircraft based on the purchase of 458 aircraft is around 119 million dollars each.[4]

History

Bell helicopter started working on tilt-rotor technology in the 1940s but the tilt-rotor idea did not start to flourish until 1951 when the XV-3 program was initiated by the Army and Air Force. [5] The program started to get more traction after Robert Lichten was hired by Bell from the Transcendental Company that had been working on its version of the tilt rotor, the 1-G. Eventually the XV-3 made its first flight in 1955 but crashed a couple of months later before completely converting to airplane mode.[6] Later Ames and NASA engineers began testing models of the aircraft in the late 1950s to test characteristics of the aircraft in the airplane mode. NASA pilots and engineers also worked on and flew the next XV-3 that was built. One major change in the new aircraft design was from a 3 bladed system on each rotor to a 2 bladed semi-rigid system.[7] In 1959 the Bell XV-3 was the first aircraft to convert from helicopter to airplane and back again in a single flight. This aircraft flew over 250 flights before it was damaged in wind tunnel testing in 1965. The program was stopped in 1966 partly due to design problems with rotor flapping and pylon stability. This aircraft proved that the tilt-rotor concept worked but the war in Vietnam led to reductions in spending for research and development of military projects and this project was mothballed until the 1970s.

In the 1970s NASA got together with the Army and the Navy to sponsor a competitive demonstration program that led to the Bell XV-15. There were two airplanes built and together they logged over 650 flight hours and 1,000 conversions from helicopter to airplane.[8] One major design change from the XV-3 to the XV-15 came about by putting the engines on the wings

instead of a single engine in the center of the aircraft. That, along with better turbine engine technology, made great strides at improving the performance of the aircraft. The XV-15 program was useful in researching and improving hover performance, rotor wash characteristics and noise signature. During the same time period, Bell's and Boeing's advances in composites and electronic flight control systems made this program more viable.[9] After the XV-15 was in a flight demonstration at the Paris Air Show in 1981 the Department of Defense started the Joint Service Advanced Vertical Lift Aircraft (JVX) program which was a joint service program to investigate the use of tilt-rotor technology to replace the then current medium lift tactical transport aircraft in the military. For the Marine Corps this was the CH-46E and CH-53D.[10] Soon after the program was started, the services established a set of requirements for a new rotorcraft and by early 1983 the basic parameters were complete. A request for proposal (RFP) was released by the military and the Bell-Boeing proposal was submitted.[11]

The Original Plan

The Preliminary Design Stage 1 for the V-22 started in April of 1983 and was to develop a configuration that would work for the medium lift assault support mission and fit into shipboard design requirements while reducing the technical risk associated with tilt-rotor technology.[12] One of the shipboard design requirements was that the aircraft had to fit within the same footprint when folded that the CH-46E did to allow the same number of aircraft to be transported on the U.S. Navy's ships. The basic requirements for the initial design of the V-22 was for the aircraft to have a takeoff gross weight of 40,000 pounds, short takeoff roll weight of 60, 000 pounds with additional internal fuel for self deployment. It had to carry a 10,000 pound payload for a 1,000 nautical mile range, have a cruise speed of 275 knots at sea level and 300 knots at 16, 000 feet and 4-g maneuverability.[13] During the 30 months in Design Stage 1 over 7,000 hours of wind tunnel testing and development were done to refine the design.[14]

The second stage started in mid-1984 and its major aim was to reduce the risk of the Full Scale Development program (FSD), design and procure long-lead time parts and select subcontractors.[15] A proposal for the Full Scale Development program was submitted to the Department of Defense in early 1985. This fixed price contract required specific weight and performance guarantees from the Bell-Boeing team. The FSD started in 1985 and included six flight test aircraft, a static test article and a fatigue test article among many other supporting tests to verify the structural design. Engine selection was also supposed to take place during this time period.[16] The first flight was scheduled for early 1989 with production to start in late 1989.[17]

Development and Testing

One major contributor to the success of the V-22 program has been in the use of composites for weight savings, strength and corrosion resistance. The aircraft is approximately 60 percent carbon/epoxy and 10 percent fiberglass/epoxy by weight. These materials were tested for reactions to temperature, moisture, pressure and long-term exposure to sunlight. These materials were tested in a building block approach starting with the resin itself and ending with full airframe section tests.[18]

Computer programs and simulation also played a major part in the design and contracting of the V-22. Three different simulators from NASA-AMES, Boeing Vertol and Bell Helicopter were used for over 1, 000 hours, of which over 300 hours were formal piloted evaluations from 1983 to 1985.[19] This type of simulation early in the program was necessary due to the aircraft having to handle both like an airplane and a helicopter. The simulation was used to define the control law logic and even the actual control design with pilots flying six different configurations.[20] As time moved on, and delays set in, testing was drawn out beyond the original plan.

Operational Test II A thru C was conducted from 1994 thru 1997. These tests covered ship operations, maintenance, tactical missions, operational training, software and documentation reviews.[21] These tests included the first of the Engineering and Manufacturing Development (EMD) aircraft which first flew in February of 1997.[22] Out of these tests some concerns came up. These issues included prop-rotor downwash during fast-rope and hoist insertion and extraction exercises, communication, navigation and crew field of view. The things that worked better than expected were the aircrafts payload, range and speed.[23]

During testing the V-22 has changed and/or exceeded some of the original design parameters. Currently the V-22 has a takeoff gross weight of 47,500 pounds, short takeoff roll weight of 60,500 pounds with additional internal fuel for self deployment. It can also carry a 10,000 pound payload for a 50 nautical mile range on a hot day. The V-22 has a cruise speed of 240 knots at sea level but has flown at over 340 knots and has shown 3.9-g maneuverability in flight testing, all of which are great capabilities.

Current Plan

At this time, only East coast squadrons have transitioned to the V-22 but West coast squadrons will begin transitioning soon. Within the last four years pilots have been allowed to choose the V-22 out of primary flight training. That primary pilot will go to initial helicopter training like helicopter pilots do and then go to additional training in the C-12 before going to HMM (T)-204 for V-22 specific training and then on to their fleet squadron. Currently squadrons are decommissioned and transitioned as a whole unit with the addition of these initial pilots. The first CH-46E squadron to transition to the V-22 after coming back from deployment was VMM-263. They have subsequently had successful deployments to Iraq and as a MEU ACE squadron.[24] They were followed by VMM-162, VMM-266 and VMM-261 and will be joined by VMM-365 in February/March of 2009.[25] These squadrons are now making rotations

to Operation Iraqi Freedom. VMM-266 is currently in Iraq filling the medium lift support role out of Al Asad Air Base. The V-22 squadrons in Iraq are flying the longer assault support missions that would be too long for the CH-46E to perform without stopping for fuel and that would take the CH-53E a full day to complete due to its speed. The Osprey can fill this mission and still have time to do additional tasking due to their greater speed and range than the two platforms it was designed to replace, the CH-46E and CH-53D. The V-22 will soon deploy again as the MEU ACE increasing the collective knowledge of ship board operations for the V-22 community. The Osprey has also been looked at as a possible medium lift platform to be sent to Afghanistan in late 2009 due to its increased speed, range and payload capacity over the CH-46E. The exact squadron for this deployment has not been designated yet.

Threats and Solutions

> "A greater threat in dealing with developing nations and non-state actors will be from the proliferation of MANPADS. Like other SAM systems, MANPADS will improve throughout the midrange in terms of increasing seeker range and sophistication."[26]

Properly escorting and protecting this aircraft and its passengers is one of the most important shortfalls in the medium lift replacement strategy. The threat is real and cannot be wished away by thinking that we will fly above the threat. That argument only partly works during the en route portion of a flight. The SA-7 has many versions and has been proliferated through out the world as a relatively cheap asset to forces of both recognized militaries and irregular forces. With a maximum altitude of 4,500 meters this weapon starts to reduce the advantage the V-22 has in en route flight altitude.[27] The V-22 is limited to 13K feet MSL with passengers on board due to the lack of oxygen for passengers. This limit is set for all unpressurized aircraft.[28] Flying at a higher altitude with greater speed and a smaller noise signature in airplane mode limits the acquisition time for the enemy and makes the V-22 a much

less detectable aircraft than the CH-46E and because of that it increases its survivability. If however you are flying in North Korea, Afghanistan or many other countries where the terrain comes up to six or seven thousand feet then flying at 13K feet MSL is not high enough to get you out of the range of this weapon system and terrain flight techniques must then be used. The SA-16 is an improved IR missile with slightly less altitude range than the SA-7. It has a maximum altitude of only 3,500 meters,[29] still within the flight envelope of the V-22. The same advantages and disadvantages apply to this system as they do to the SA-7. Components to these two weapon systems are still being found every day in Iraq over five years into the conflict there. This was also the weapon used to shoot down a CH-46E in Iraq on 7 February 2007. This shoot-down proves that MANPADS are still a threat even in a mature theatre of operations. They are an even greater threat in a country where the Marine Corps is making a forcible amphibious entry where we have little intelligence. This IR threat does not include the myriad of AAA weapons and RPGs that are easy for militaries, armed groups and terrorists around the world to acquire. The V-22 is far less susceptible to these weapons en route due to its ability to fly faster, higher and quieter than conventional helicopters but, while ingressing or egressing the landing zone those advantages quickly melt away. This is the time when the V-22 is most vulnerable and needs a defensive weapon, IRCM and an escort.

Currently the rotary wing escort duties for the V-22 are the responsibility of the HMLA squadrons of the Marine Corps. This mission is currently filled by the AH-1W. The AH-1 has been around since the 1960s and has been used with great success. It came about as a derivative of the UH-1 that was being used in Vietnam. It was determined that with a cut down fuselage and increased armament the United States would have a formidable weapon. The initial AH-1s the Army received had a single engine but soon the Marine Corps required a second engine be added for redundancy in a shipboard environment. Over the years additional improvements have

been made to increase the lethality of the AH-1 to include night targeting capabilities, 20 mm cannon, and the ability to fire TOW, Hellfire, and/or Zuni rockets. With a maximum cruise speed of 152 knots and a standard combat radius of just over 125 nm, this aircraft is a great escort/CAS platform but it can not adequately protect the V-22 as an attached escort on its missions.[30]

To mitigate this shortfall the AH-1 can launch on a mission prior to the V-22 to do detached escort and then join the V-22 flight a few miles prior to the LZ or take up a battle position near the LZ prior to the V-22's arrival. On the longer range missions of the V-22 the speed and range differences for the escort aircraft would also require a FARP be set up in advance for the escorts. This FARP would require more assets and increases mission complexity. It also increases the force protection requirements and could eliminate the element of surprise all together.

Currently the V-22 does not fly in formation with any helicopters in the Marine Corps inventory such as the CH-53E. This is so the Marine Corps can take full advantage of the V-22's speed, range and altitude envelope to avoid many different threats. That means that any mission that would require heavy lift assets would also require additional escort assets since these two assault support aircraft no longer fly together in tactical formations. This additional escort requirement reduces the amount of assets available to ground commanders for CAS. These escort and CAS assets are already a limited commodity for all Marine Corps operations. This problem will continue to exist with any escort option the Marine Corps chooses based on the fact that even the anticipated CH-53K will only have a top speed in the 170 knot range. A mission like that given in appendix A would require 3 CH-53Es to be used for the FARP escorted by 2 AH-1Ws launched 3 hours and 30 minutes prior to the L-Hour. This package would be followed by 2 additional AH-1Ws launched 3 hours prior to L-Hour. None of these aircraft would

perform attached escort for the Ospreys but instead conduct a route reconnaissance. Followed by 3 MV-22s launched one hour prior to L-Hour. This gives an on station time for the escort/CAS aircraft in the zone of 30 minutes before and after L-Hour if required.[31] At no time will the V-22's have an attached escort but they will have protection in the zone which is the most critical portion of the mission for the V-22s and the passengers on board since the V-22s have little self protection capabilities.

In the future the rotary wing escort mission will be done by the AH-1Z. The AH-1Z is a 4 bladed variant of the AH-1W now being used by the Marine Corps. This aircraft will have a great increase in its ability to carry much larger stores of weapons to higher and hotter environments along with better sensors to target the enemy. With an 84 percent commonality of components with the UH-1 program this will help reduce overall operating costs for the Marine Corps.[32] At this time the mission radius of the AH-1Z has not increased much over that of the AH-1W. The Marine Corps can reduce the weapons stores on the AH-1Z for longer missions and add additional fuel in pylon stations increasing the mission radius of the AH-1Z.[33] However, the speed differential will still be an issue for mission planning causing the AH-1Z to perform detached escort for most of the mission and joining the V-22s for only the last portion of the mission. This is contrary to the way CH-46s and 53s were escorted in and out of the higher threat areas of Iraq even as late as the fall of 2007.

Since neither of these escorts completely fills the requirement for a rotary wing escort the Marine Corps must look to the future as it did with the Osprey. One good example of an aircraft that could quickly, relatively speaking, be placed in the escort role is the B/A 609. The B/A 609 is a small civilian version of the V-22. It is close to delivery for the first civilian customers and should be easy to bring to military service within the next decade using data and systems used on the V-22 now. With a speed of 275 Knots and a range of 750 miles using its current fuel

capacity it matches the V-22 more closely than any other aircraft on the market right now.[34] The ability to fly in the same performance envelope has been touted many times in the past to give the most protection and most flexibility when escorting assault aircraft.[35] The non-folding wing and rotors on the B/A 609 would cause shipboard storage issues because the foot print would be much larger than that of an AH-1Z. If one looks at the BA-609 as a replacement for both the AH-1 and UH-1 you gain a lot more in efficiencies of scale by having just one aircraft performing a dual role. That may make it worth the additional cost, effort and logistical issues if it would better protect the most expensive rotary wing assault support asset in the world. If testing began now the Marine Corps would still be looking at 12 to 15 years before the first aircraft could be fielded. But having a force of compatible tilt-rotor aircraft will also yield efficiencies in other places such as training, procurement and support contracts with the manufacturer. In the scenario listed in appendix A, the escort mission for the V-22s could be done by a section of B/A 609s or two sections if more on station time is required by the ground commander. This could be done without the risk and complication of the FARP mission and would free up the FARP assets for another mission.

If the B/A 609 were not thought to be viable due to the testing and redesign then the Marine Corps should be looking into the Sikorsky X-2 program. It is a tandem seat helicopter anticipated to fly in the 200 knot range. It uses counter-rotating main rotors which the Russians have been using for years. Since this program is still in its infancy the Marine Corps would be looking 15 to 20 years into the future to field this system. If rotary wing assets can not fill the requirement then fixed wing assets must be looked at to fill the escort role.

Currently fixed wing escort on the MEU is done by the AV-8B Harrier. This is done as a detached escort due to the speed differential between the V-22 and the Harrier, even though the Harrier can fly in the mid 200 knot range it would not want to fly that slow in a MANPAD threat

environment. In route to the zone this detached escort is not as much of an issue but as the V-22 approaches the landing zone the Harrier must go into an overhead orbit above 15,000 feet or 6-10 miles out depending on the weather and threat.[36] This CAS stack will be larger and higher than any R/W escort BP due to the flying characteristics of the Harrier and the need to stay out of the range of the MANPAD threat. Anything lower would place the AV-8 at a higher risk. MANPADS and AAA weapons are widely proliferated throughout the world and are abundant in the Middle East, North Korea and Africa. Another issue arises if there are cloud layers in the area of the LZ. The V-22 can fly under the cloud layers to accomplish its mission of delivering troops in the required landing zone in weather down to 500 foot ceilings and 1 mile of visibility but the faster moving fixed wing escort would not be able to effectively employ CAS procedures below a cloud layer of 3000 feet AGL. This has become an issue many times in the past and was documented during the Vietnam War, which prompted the use of helicopter escort for assault helicopters. Another issue has been in on-station time. The Harrier can support the mission off of the ship but would need to tank or reduce their weapons stores to be able to get the endurance needed for the longer Osprey missions. MEUs would be hard pressed to get tanker support in many instances especially if the mission was short notice. The Marine Corps could however use multiple sections of Harriers to allow for time on station for CAS after the Marines have been dropped in their LZ. This is doable but not sustainable for any length of time.[37] This is due to the small number of Harriers carried on a MEU.

Another fixed wing asset that the Marine Corps can currently use for the escort mission is the F/A-18 Hornets. This aircraft can perform the mission as a detached escort just like the Harrier. However, this aircraft can not launch from an LHA or LHD like the Harrier so there must be an aircraft carrier or a country friendly to the US from which the Hornets can launch. As with the Harrier the speed differential also causes unnecessary risk for the F/A-18 in the

escort role. This may place the F/A-18 in peril due to the size and altitude of its overhead position or reduce the effectiveness and responsiveness of its fires. As with the Harrier, the ability to fire in close to the LZ would be limited in a measure to reduce the incidence of fratricide with Marines when they exit the Ospreys.

Harrier or Hornet pilots may not feel that this is a problem since there are many CAS procedures in use everyday but some ground commanders would consider it a much higher risk to launch on a mission in which the fixed wing escort/CAS assets would have to drop bombs, shoot rockets or use their gun in close proximity to troops as they are debarking Ospreys in the LZ. Some ground commanders consider the R/W assets to be a more effective close-in tool both in weaponeering and fires deconfliction.[38] Responsiveness is also an issue when Marines are exiting aircraft and taking fire while the assault aircraft are trying to egress the zone. If the Osprey had an adequate gun that could be used to cover Marines this could be mitigated.

Currently the only self protection for the V-22 is the ramp mounted M240G which is a 7.62mm light machine gun. This system only allows the aircraft to fire at targets to the rear of the aircraft. The need for this capability can be seen as recently as OIF when a CH-46E door gunner took out an enemy sniper while waiting to get into an LZ on a CASEVAC mission. The higher airspeeds and altitudes the V-22 flies reduces the need to fire at targets to the side of the aircraft during the en route portion of a mission but it does not reduce the risk or the possible need for suppressive fire approaching or leaving the zone.

Programs are underway to add an additional weapon to the belly of the aircraft in the hell-hole location. The anticipated weapon is the GAU-17, a 7.62 mm electric gun capable of firing at rates of up to 4000 rounds per minute or the GAU-19 firing .50-cal ammunition. This would increase the self protection capabilities of the aircraft but limit the flexibility of the aircraft. Currently the system being tested cannot be removed easily, which means that the

aircraft cannot be used for external cargo lift operations for a minimum of two hours while the gun is removed.[39] Once the gun is removed for external operations the Osprey can no longer protect itself. Also, this weapon would reduce the number of available seats by two[40] and reduce the speed at which the Marines can exit the aircraft since the weapon sits in the middle of the aircraft's floor. This current weapon being tested has to be retracted before landing, giving it no ability to fire while on final approach to the landing zone, in the zone or immediately on take off unless the aircraft hovers first. This would require aircrews to make a choice between self-protection and the ability of Marines to perform their mission in an environment where the aircraft cannot land (externals) or reduce protection in the zone due to the weapon retracting.

The Air Force is developing much more in the form of self protection on their version of the Osprey, the CV-22 that will be used for special operations. Some of the systems are directed infrared counter measures (DIRCM) and terrain following radar among others. The DIRCM system will utilize an advanced infrared sensor and two turreted lasers to confuse infrared missiles, drawing them off their target. This system will enhance the abilities of the Air Force CV-22 to work without an escort along with other systems that will be integrated in the Air Force SOF version of the V-22. The mission the Air Force SOF aircraft fly allow them to choose the time and place of landing more freely than the mission of the MV-22s in the Marine Corps. Based on the difference in missions, some of the systems on the CV-22 may not be applicable to the MV-22. However, DIRCM and a self protection weapon would reduce risk on most missions for the MV-22.

If the Marine Corps wants to escort the V-22 with an aircraft that is more compatible in its flying characteristics of speed and range, it should look at the A-10. The A-10 has a proven combat record during Desert Storm and since. It was built for the close air support role and is well-armed for the mission and has gone through a number of upgrades over the years. It has the

ability to be used from shorter airfields. It has a cruise speed of 300 knots and the ability to go upwards of 380 knots. It has a combat range of 250 nm and carries a 30mm cannon, missiles and rockets to perform CAS and FAC responsibilities along with chaff and flares for self protection.[41] Admittedly, the major drawback to this solution is the inability of this aircraft to be launched from a ship, the design is old and the production line has been shut down. These are not insurmountable problems, but they are not easy problems to fix either.

Looking into a less expensive solution would lead us to a modified version of the T-6 Texan II training aircraft. At a current cost of 4.7 million dollars per copy and years of flight data under its belt as a training aircraft this is a cost effective choice.[42] Even if the cost per copy doubles due to testing and engineering, this aircraft would work to fulfill the mission and be a cost effective choice. With a speed of 320 miles per hour, a range of 900nm and a ceiling of 31,000 feet it matches or exceeds the V-22 flight envelope.[43] The military of Argentina has taken the T-34 trainer and used it for many years. The same could be done with the T-6 for the United States. It however has the same issue as the A-10 in that it can not be taken aboard ship. It has the additional issue of needing testing done to verify all the changes required to arm and protect the aircraft.

A better fixed wing solution to the escort and CAS mission for the Marine Corps is the Embraer Super Tucano EMB314/ALX/A-29. It has been designed to fly in all weather and 24 hours a day with NVGs and it uses precise navigation equipment, GPS and thermal imaging. It has been designed to fly +7 and -3.5G and has a small size and small radar signature partially due to the 36.5 foot wingspan and 37 foot length. It has a 1600 SHP Pratt & Whitney engine and a five bladed Hartzell propeller giving it plenty of power to handle many different weapons including a 12.7mm gun, air-to-air missiles, guided and unguided bombs and rockets. It also has armor protection for the pilots and critical systems redundancy. With a HUD, HOTAS, oxygen

and zero-zero ejection seat this aircraft was designed with many of the systems a fighter pilot is used to using now.[44] It can also be flown from smaller and more austere airfields.

This aircraft and the slightly less powerful EMB-312 are being flown by militaries around the world as a trainer. The RAF, French Air Force, Kuwait Air Force and the US military contractor Blackwater are all using it for training. Many South American countries are using it as an inexpensive attack/observation and FAC (A) aircraft at this time. Brazil has purchased many and Columbia is using it to replace their OV-10s just to name a few.[45] The last contract to a South American country came in just under 10 million per copy for a buy rate of only 24 aircraft. For this price the United States could buy enough to have six squadrons on the East Coast, six on the West Coast, one on Guam (when the Marines relocate there), one on Okinawa and additional aircraft to be placed on MPS ships for contingency use for 1.5 billion dollars. Depending on the cost numbers used that means giving up about 15 to 20 V-22s will pay for this protection and to add an additional CAS/FAC (A) platform to the US inventory. Since it is a turboprop it also has a much lower operating cost per flight hour than a jet or a helicopter.

Manpower is always a concern but the manpower could come from reductions in other areas within the expansion of the Marine Corps aviation plan. With the protection of the most expensive assault asset and the Marines on board at stake, this out-of-the-box solution may be the most economical and quickest to bring to operational use for the Marines. It is also marketable to our allies that do not have the large defense spending budget that the United States has such as the Philippines. It is made by a Brazilian company which would produce political benefits with that country and has already partnered with US companies for many of its systems. Increasing the partnership shares would not be difficult and would strengthen ties with this US ally.

Currently CAS missions after forces are on the ground will have to be filled by fixed wing assets due to the fact that current rotary wing assets cannot range the same locations as the V-22. With Operational Maneuver from the Sea, STOM and ECO, this problem will continue to grow unless the Marine Corps looks into procuring an asset that can fulfill this role. The economic waste of flying the Osprey at less than its most optimum operating characteristics should also be a concern.

Possible aircraft have been touted in the past to replace the V-22 Osprey. That was in the past and at this time no one should be looking to eliminate the V-22 program. It is such a great asset to the Marine Corps and the United States. What should be discussed is the addition of another aircraft to the Marine Corps inventory. This additional aircraft can supplement the V-22 and CH-53E inventory to expand capabilities, more closely match current escort capabilities in range and speed and create a more cost effective solution to the overtaxed medium and heavy lift rotary wing squadrons in the Marine Corps. This aircraft could also form the bridge between the CH-53E and the CH-53K procurement programs.

The Augusta Westland AW-101 which is being sold to the United States as the US-101 for the presidential support mission is a proven military helicopter with militaries around the world. It has large cargo doors and the ability to carry 27 combat troops or over 10,000 pounds of cargo internally or externally. It also has the ability to air-to-air refuel and can be transported in a C-17.[46] The AW-101 has modern avionics making it an all weather aircraft capable of flying in known icing conditions. It also has Directed Infra Red Countermeasures (DIRCM), Missile Approach Warning Systems (MAWS), Radar Warning Receivers (RWR), Laser Warning Receivers (LWR) and chaff and flare dispensers for increased survivability on the battle field.[47] These items are commonly referred to as Aircraft Survivability Equipment (ASE). This aircraft can also mount machine guns on its left and right side and the ramp. This does reduce the

number of available seats for combat troops. It also contains multi function displays and modern safety and mechanical health monitoring systems. It is fully compatible with shipboard operations to include blade folding. With a maximum cruise speed of 150 knots, a typical cruise speed of 136 knots, a hover in ground effect of 11,300 ft and a hover out of ground effect of 3,500 feet it is more compatible with the flying speeds of the AH-1W and future AH-1Z. With 24 passengers weighing a total of 6000 pounds the aircraft has a combat range of 200nm.[48] Though this range is greater than that of the AH-1Z with the addition of external fuel tanks on the AH-1Z it can more closely match the performance of the US-101.

The Sikorsky H-92 which is the military version of their commercially sold S-92 has similar performance standards to the AW-101. The H-92 has 2 engines instead of the 3 engines of the AW-101. The H-92 also has many of the same ASE systems that are on the AW-101. Its speeds are similar to the AW-101 and combat radius is similar. The difference being that the H-92 would hold only 22 total passengers compared to the 101's 27 passengers.[49] Air-to-air refueling capability is not currently installed on the H-92 but has been looked at by Sikorsky and could be quickly adapted since it has done so on many of its current models. With speed and range being very similar to the AW-101 it can be escorted by the AH-1W or AH-1Z. Based on the scenario listed in appendix A the H-92 could do the mission with up to 16 troops per aircraft cruising at 3500 feet and 130 knots.[50]

An additional selling point for the H-92 would come in the possible changes to the CH-53E/D squadrons. Though the H-92 may not be as capable as the AW-101 in total weight carrying capacity or passenger carrying capability, it may be able to exceed the AW-101 in efficiencies gained by adding this aircraft to the HMH squadrons of the Marine Corps. By contracting with Sikorsky for the H-92 the Marine Corps can then formulate future contracts with Sikorsky for the CH-53K program. By using common avionics, aircraft survivability

equipment and other cockpit components and power by the hour contracts for engines and drivetrains, the overall savings would be greater when choosing the H-92 over the AW-101. With only two engines instead of the three engines of the AW-101 the required maintenance and fuel consumption would be much less when looking at the H-92. Another increase in efficiency over the AW-101 may be gained in manpower. By adding this aircraft to existing CH-53 squadrons with common components and flight systems you can add another capability to the Marine Corps by adding minimal additional personnel to a squadron without adding completely new squadrons. The flight systems in both the H-92 and CH-53K could be common enough that the pilots could be NATOPS qualified for both aircraft. Then the aircraft can be chosen that would most effectively complete the required mission. With similar components in avionics and other systems the Marine Corps could also keep the additional maintenance Marines required in a larger squadron to a minimum. HMLAs are using two different aircraft now and have been doing it for years with great success. With the H-92 and the CH-53K being more closely related mechanically the Marine Corps could gain even greater manpower efficiency than the HMLAs currently have.

Initial cost is one major issue with the procurement of new aircraft. Currently the V-22 is approaching 119 million dollars per aircraft. If the CH-53D squadrons were not to transition to the V-22 but instead transition to the H-92 and eventually to a combined H-92/ CH-53K squadron the Marine Corps could save a lot of money. For example: 3 CH-53D squadrons transitioning to the V-22 would be approximately 40 aircraft. If these squadrons transitioned to the H-92 instead of the V-22 at 50 million dollars per aircraft for the H-92 that additional money could go to purchasing another 40 aircraft, bringing the total H-92 buy up to 80 aircraft for less money than the 40 V-22s they would replace.

The initial cost of 50 million dollars per copy is based on the current cost per copy of the H-92 contract entered by the Canadian military purchasing 28 marinized aircraft. With the United States buying more aircraft, the cost per aircraft should decrease if we do not change too many requirements in the contract. If the Marine Corps made the decision to reduce the number of CH-53Ks per squadron from 16 down to 12 but supplemented them with the H-92s, the squadrons would actually have 18 aircraft each being a mix of H-92s and CH-53Ks. These numbers are based on the anticipated changes in end strength with the addition of CH-53 squadrons in the current Marine Corps aviation plan. The actual number would be determined by what the Marine Corps actually does with the CH-53D squadrons and CH-53K squadrons. The H-92 could fit in between the V-22 procurement contract timeline and prior to the fulfillment of the CH-53K contracts. This would ensure that the Marine Corps had adequate lift in the future without having to continually upgrade older aircraft as the CH-53K contracts fall behind, something that has become all too commonplace in the acquisition of major systems.

Conclusions

With the current amount of cooperation between the Air Force and the Marine Corps and the testing that has already been done on self defense and survivability systems, I believe that the Marine Corps could quickly field a self defense weapon for the V-22. This additional equipment would make it more survivable in the dynamic environment it must fly in and the landing zones that it must land in to support the Marine Corps' various missions. The addition of the DIRCM system would also increase survivability and reduce the number of scenarios where the V-22 would require escort, thus allowing those aircraft to be used for CAS missions. The Marine Corps needs to make the protection of this aircraft a top priority. The loss of one aircraft due to a lack of protection is enough to sway public opinion and the opinion of Congress. This could jeopardize the program yet again. These additional systems will also allow the Osprey to take

full advantage of its current capabilities with regard to speed, range and altitude. Currently with the amount of interest that other countries have shown up to this point, foreign sales for the V-22 could begin soon with the addition of the DIRCM system and a weapon that does not decrease the flexibility of the V-22. The British have already done an independent study and have determined that the unique operating qualities of the Osprey could be quite valuable. In addition to the V-22 version of tilt-rotor technology, the BA-609 will be FAA approved and production of this aircraft started within the next five years. This would allow the Marine Corps to look at buying a military version for use in escort operations much sooner than if a whole new design had to be drawn up and produced. The Marine Corps and Navy should immediately put out a request for proposal for an escort based on the B/A 609 to work alongside the V-22 and for the BA-609 to be used in training the future V-22 pilots. An inexpensive fixed wing CAS platform like the Super Tucano could be brought into the Marine Corps inventory quickly and is the out-of-the-box thinking that the Marine Corps is known for.

Another airframe should also be added to the Marine Corps inventory. The H-92 would remove some of the operating pressure on the still burgeoning V-22 program. It would also relieve pressure on the CH-53E and future CH-53K community as the older airframe draws down and the newer airframe comes on line. It also allows for more flexibility for commanders to choose the aircraft that can accomplish the mission the most efficiently between the V-22, H-92 and CH-53 operating parameters. The V-22 is a leap in capabilities and far exceeds the capabilities of the CH-46E but due to issues with protection it can not safely or totally fill the gap the United States Marine Corps has in assault support. The cost per airframe is also high in this time of budgetary belt tightening and another aircraft can perform many of the same missions much cheaper per flight hour and per airframe initial purchase cost. Medium and heavy lift assault support assets have become overtaxed in recent years even without STOM, ECO, and any

other operations requiring some form of distributed operations. The requirements for speed, endurance, flexibility and the ability to protect those assets distributed around the battlefield will only increase in the coming decade.

Appendix A

Scenario

XX MEU is given the mission to secure a sight for the evacuation of personnel at a location 125 NM inland. The ship is 50 NM off shore for a total of 175 NM. The area is considered hostile with a medium threat level for rotary wing aviation due to the number of small arms, heavy machine guns and shoulder fired weapons in the country. Weather is anticipated to be 2000' ceiling and 3 miles of visibility in the landing zone at the time of landing. Atmospheric conditions put the landing zone at 6000' DA at the time of the mission. The BLT has determined that they will need 34 Marines loaded to 240 pounds each. They will also need 500 pounds of additional gear. They require 15 minutes of CAS on station in the landing zone. They anticipate being ready for extraction 6 hours after landing in a different landing zone.

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